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ABSTRACT

This paper reports the results of a survey of a number of high technology companies in Canada who were asked to provide information about their relationship with the educational system, the application of their products in education, and their views on the implications for education in general of the new technology in information and communications. It is noted that the 20 respondents represent producers of educational software, especially programs for computer-assisted learning and authoring languages; telecommunications systems; mainframe and microcomputers; and work stations (some without direct application in education). The information provided by the respondents has been grouped thematically. The first section covers the broad theme of the changes in education and society that will be hastened by the integration of the new technology. The effect on the curriculum and teaching methods in elementary and secondary schools is discussed in section 2. The third section considers the relationship between education and training, and how it might change according to the demands of the technological workplace. The fourth section reports on how the special educational needs of high technology employees are being met by the higher education system, while the fifth presents high technology's futuristic vision of education and how that vision might be made more consistent with the promise of technology. The final section examines and critiques the respondents' vision of the influence of technology on education. A list of the 20 contributing companies is included. (DB)

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NEW TECHNOLOGIES IN CANADIAN EDUCATION

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PAPER 16

THE HIGH TECHNOLOGY INDUSTRY AND EDUCATION IN CANADA

By Judith Tobin

Study Coordinator
Ignacy Waniewicz

January 1984

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Copies of these papers can be purchased from TVOntario, Box 200, Station Q, Toronto, Ontario, Canada M4T 2T1.

FOREWORD

We dedicate this series to its designer and director, Ignacy Waniewicz. His death on February 21, 1984, has left us with a feeling of immeasurable loss.

With uncanny intelligence, instinct, and energy, Ignacy introduced the first educational television programs in his native Poland in 1957 and rose to the position of Director of Educational Broadcasting. During the mid-1960s, he served as a Paris-based program specialist in the educational use of radio and television, working for UNESCO in Chile, Cuba, Ivory Coast, Upper Volta, Mexico, Egypt, Nigeria, Senegal, Ghana, Great Britain, United States, Switzerland, and Israel. Ignacy shared the experience and insight he gained from this work by teaching and writing in Polish, German, Russian, Hebrew, Spanish, French, and English. His achievements are widely recognized in the broadcasting and academic communities on four continents.

As Director of the Office of Development Research at TVOntario, Ignacy explored his farsighted and consuming interests in adult education, media literacy, television as a primary tool for lifelong learning, and most recently, the educational uses of new technologies. His work did much to shape and guide TVOntario's progress over the last 15 years.

It is with love and respect that we dedicate this series to Ignacy Waniewicz. In its enormous scope, its thorough documentation, its emphasis on concrete results, and its concern with educational issues, this series reflects both Ignacy's vision and his intellectual legacy.

Donna Sharon
for the Office of Development Research

Preface to the Series

NEW TECHNOLOGIES IN CANADIAN EDUCATION

These papers in the series "New Technologies in Canadian Education" are the result of an international commitment. In June 1980, the Third Conference of Ministers of Education of Member States of the European Region of UNESCO adopted a recommendation requesting the member states to carry out joint comparative studies on well-defined problems of common interest in education. At a subsequent meeting of the European Region National Commissions for UNESCO, 14 subjects were agreed on for joint studies.

The theme "New Technologies in Education" was selected as study #11. The 17 countries participating in the study are Austria, Belgium, Denmark, Finland, France, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, Ukrainian SSR, USSR, United Kingdom, as well as Canada, Israel, and the U.S.A. who are also members of the UNESCO European Region. At the first meeting of the national coordinators from these countries, held in October , 1982, at the University of South Carolina in Columbia, South Carolina, U.S.A., a plan was adopted for the study. In the first phase of this plan, the individual countries are to report on the ways in which the new technologies are being used in education. (A brief outline of the international design is available on request.)

The Canadian Commission for UNESCO was requested to coordinate, on an international level, the first year of the study. We are grateful to the Canadian Commission for selecting TVOntario, and the Office of Development Research (ODR) to be in charge of this task. The ODR was also asked to coordinate the Canadian contribution to the study, with financial support from the Department of the Secretary of State. We gratefully acknowledge their assistance.

In preparing the Canadian review of the use of technology in education, the ODR contacted a number of educators, academics, government officials, administrators in educational communications organizations, and others, across the country. It became apparent that there was a strong need for a well-documented account of the uses of both the "older" technologies (e.g., film, audio, television) and the newer technologies (e.g., computers, videodiscs, videotex) in the complex Canadian educational system.

Early in 1983, several types of research activities began simultaneously: designing instruments to gather information from each type of institution or interest group, identifying uses and users of each type of technology, and exploring the areas where Canada's distinctive features predispose toward technological developments. The 17 papers listed on the back of the title page emerged as a result.

Information for these papers was provided by hundreds of individuals expressing their own views or reporting on behalf of educational institutions and organizations, government departments, public and private corporations. We extend to them our sincere thanks.

I would like to acknowledge the contribution made by Thelma Rosen who assisted in the development of the inquiry instruments and played a major role in the gathering of this information. The task of supervising the final editing, production, and distribution of the papers was assigned to Donna Sharon. Her resourcefulness and persistence have contributed greatly to the completion of this series. Sharon Parker typed most of the papers from the initial drafts to their final versions. Her dedication made it possible to complete the study in such a relatively short period.

While the preparation of these papers has been supported by the Canadian Commission for UNESCO and the Department of the Secretary of State, the papers' contents do not necessarily reflect the official views of either party on issues related to technology in education.

Ignacy Waniewicz
Study Coordinator
Director
Office of Development Research
TVOntario

January 1984

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INTRODUCTION

The past few years have seen the rapid development and growth of a high technology industry in Canada. The products - hardware and software - of the companies as well as the expertise and advice of the technical and research staff are being used increasingly in education.

Within the framework of the Canadian review of new technologies in education, a number of high technology companies were contacted. Information was requested about their relationship with the educational system, the application of their products in education, and their views on the implications for education in general of the new technology in information and communications.

The respondents began by specifying how their companies' products or expertise are or could be used in education. Some of the firms are developing educational software, particularly programs for computer-assisted learning and authoring languages.* Manufacturers of hardware are also well represented in the group: they are producing telecommunications systems, main-frame and microcomputers, and work stations (some without direct application in education).

Firms like IBM, Digital, B.C. Tel, and AEL Microtel are offering extensive in-house training to employees and, in some cases, to customers. This has led them into the business of advising other companies and vocational institutions on educational methods and materials. Some respondents specialize in designing and selling high technology education to the public and private sectors.

A few of the companies collaborate closely with educational institutions through cooperative education programs and agreements to provide computer hardware and software, and to exchange expertise. High technology firms have contact with all levels of education and with the

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* Authoring language: a high-level programming language designed to enable people without much experience in programming to write programs of a particular kind, especially for computer-assisted instruction.

educational branches of other industries, the military, the public sector, as well as with adults who are continuing their education at home and in the workplace.

The impact of the information and communication technologies on education is of interest to the high technology industry, who would like the new technology to be integrated into education as advantageously and as quickly as possible. The impetus for this is a concern for the future of education and economic prosperity as well as a recognition of the influence that educational acceptance has on the future of the high technology industry. The industry is also an employer that looks to the educational institutions to provide competent employees.

The information received from the high tech firms has been grouped thematically. The first section covers the broad theme of the changes in education and society that will be hastened by the integration of the new technology. The effect on the curriculum and teaching methods in the elementary and secondary schools is the subject of the second section. The third section considers the relationship between education and training and how it might be modified by the demands of the technological workplace. The fourth section reports on how the special educational needs of high technology (particularly for well-trained employees) are being met by the educational system, specifically the system of higher education in Canada today. The fifth section presents high technology's futuristic vision of education and how that future might be made more consistent with the promise of technology. The final section is an examination and critique of high technology's vision of the influence of high technology on education.

Contributions to the review were received from the following firms:

AEL Microtel
Burnaby, British Columbia

AES Data Ltée/Ltd.
Montreal, Quebec

Bell Canada
Northern Telecom Canada Ltd.
Bell-Northern Research

British Columbia Telephone Company (B.C. Tel)
Vancouver, British Columbia

Digital Equipment of Canada Ltd.
Kanata, Ontario

DDS Decision Support Systems Ltd.
Edmonton, Alberta

Electrohome Ltd.
Kitchener, Ontario

Goodwood Data Systems Ltd.
Carleton Place, Ontario

Honeywell Ltd.
Willowdale, Ontario

IBM Canada Ltd.
Willowdale, Ontario

IMATA Systems Corporation
Ottawa, Ontario

International Cinemedia Center Ltd.
Toronto, Ontario

Kanata High Technology Training Association (KHTTA)
Kanata, Ontario

Logo Computer Systems Inc.
Lachine, Quebec

Manitoba Telephone System
Winnipeg, Manitoba

Mitel Corporation
Kanata, Ontario

NABU Manufacturing Corporation
Ottawa, Ontario

Saskatchewan Telecommunications (Sask Tel)
Regina, Saskatchewan

Spar Aerospace Ltd.
Mississauga, Ontario

Systemhouse Ltd.
Ottawa, Ontario

TECHNOLOGY, EDUCATION, AND CHANGE

The new technologies in information and communication have the potential to change every aspect of education. The respondents from the high technology industry unanimously expressed the view that the availability, and particularly, the location of education would change because of the new technologies. Mitel defines the extension of education to the home: "Use of computers and communications in education could be very powerful in programs that are tailored to the individual. This could also make more education at home a potential concept." Broader accessibility is the concern of Sask Tel in forecasting "the extension of school into the home, elimination of distance as a factor, twenty-four-hour learning availability." Systemhouse predicts not only that the home will become a learning centre but also that "working adults can learn at home or on the job." This statement is supported by the extensive employment-centred programs for, and using, the new technologies that are offered by IBM, Digital, B.C. Tel and other firms. International Cinemedia predicts a much wider range of new learning locations. "It seems to me that the newer technologies have a very significant capacity for educating people in informal settings that are recreation or work-related: the home, public science exhibits, the workplace, the library, and new kinds of learning/entertainment environments made possible by interactive technologies." The Manitoba Telephone System suggests many uses for the technology, such as "to deliver educational video material from central libraries to urban and rural schools and to handicapped students at home or in institutions; for evening credit courses; for continuing education to the public; for specialized professional training and special events."

The Bell Group considers the effects that these changes will have on formal education: "Less of the total learning will take place in schools and universities. Much more will take place in factories, offices, and, especially the home." NABU also comments on the effects on institutions: "Institutions as places of learning will change. They will be reduced in number and their role will evolve to make courseware available via media to homes and businesses."

While not questioning the potential impact of technology on education, International Cinemedia expresses concern about

the probability of this impact. "At first glance, the implications of the computer and related technologies for education would seem to be tremendous - and inevitable - but there are different kinds of educational processes and organizations that go with them and, in many cases, viewed from inside these organizations, the new technologies threaten to have a very negative effect. Thus I expect significant effort will be expended in some quarters to contain or sideline the possible impact of the technology while paying lip service to it ... It will require an informed and involved public to make sure that the educational possibilities inherent in the computer are not dissipated, ignored, or distorted, so that reactionary educational establishments - especially in the poorer nations - do not simply maintain the status quo, with the real use for computers taking place outside the schools, in the home, workplace, or elsewhere. That would be a tremendous duplication, as well as a social waste and financial burden for all concerned."

It is generally presumed and hoped that education will become more widely available because of the new technologies. The Bell Group presents the converse point - that the new technologies will make education more necessary. "For those leaving school to enter the work force, the skills and information base needed for initial employment are not likely to be those needed for the same job a few years later." Quoting from the Science Council of Canada, the Bell Group contends that "one quarter of all present factory jobs could be eliminated by robots and automated manufacturing processes by the end of this century." A more optimistic employment future is predicted by the Canadian Advanced Technology Association: "New technology could create half a million jobs in Canada by 1990." The Bell Group uses those two figures to indicate "only part of the magnitude of the learning and retraining task that confronts Canada. The challenge will be to provide resources for education and training that will be required for massive job changes. It will require not only more education and training, but more effective education and training." Thus, the composition of the learner population will change to include those already in the work force and the subjects studied will be "subjects related to the work environment" (NABU).

The high tech industry's opinions of the implications for the education system of the new technologies concentrate,

then, on greater availability, particularly in the home and workplace, and on new learners and courses directly related to the changing workplace.

Many of the respondents look beyond the educational system to the effect that the new technologies in education would have on society. Honeywell describes a beneficial contribution that educational technology can make: "In a country such as Canada, regional disparities as applied to the quality of schools and education can be greatly diminished over the years to come. A bright student living in the most remote and small corner of this country, as long as it is served by communication systems, can participate in the same quality of learning as his brother can, living and attending our finest schools in our best serviced areas." Referring to postsecondary education, the Bell Group quotes from the Queen's University report[1] on new information technology. The results of offering home learning packages "are likely to include an increasingly egalitarian distribution of postsecondary education...that will cost much less than a year at university." Electrohome looks at the same possibilities - but not so positively. "The individual student will have access to teaching facilities which will allow ambitious ones to move ahead very rapidly. The facilities will also take a lot of the learning experiences out of the classroom and into the home environment. If this is not handled carefully, the class differences between the have and the have-not population will widen very rapidly ... It is up to the school system to allow the have-not population to compete." Although the technology can be used to show students the range of possibilities, it will not necessarily allow more equal access to those opportunities.

Once the new technology is widely used, NABU thinks that "students will pass through the traditional curriculum in shorter time (i.e., seven years rather than thirteen years), thereby causing changes in the postsecondary area, social and business environments." There is little speculation on the nature or results of this change except that the public and industry will have to contend with the way that the new learners have been taught. Electrohome is concerned about the new generation of the computer-educated. "Difficulties are foreseen for people at the personal level in the future ... Regardless of individual accomplishment, people must integrate with others to accomplish meaningful tasks. The question will then be how to integrate individually trained

people into a collective effort world." This is the only reservation expressed directly about the change within learners that might be affected by learning that is primarily computer-based.

International Cinemedia predicts that education will temper some of the more extreme reactions possible in society: "Technological change cannot be avoided, but the general public must have a chance of shared ownership in it. They must not be dragged along by it, or a violent reaction is likely. That is where education has an essential role." Goodwood Data Systems also expresses fear about the social and economic disruption possible because of technology, but assigns the crucial role of intermediary to governments which will have to formulate policies to lead this technological revolution.

Technology will alter every component of the educational process. Conversely, some of the respondents deliberated on the effects the education system would have on technology. The Bell submission particularly explores this theme under the subheading "The Economic Need to Learn." "Whether or not new information technologies will fulfill their potential will depend, in part, on the kind of action that is taken by our educational institutions." The Bell statement links the knowledge of, and the ability to use, computers with the increased Canadian productivity necessary to compete in international markets. "The global marketplace ... is in large measure a product of communications technology ... Canada may be losing its position in global competition" (Bell). To meet the economic challenge, Canada needs strong research, science, and technological resources for postsecondary education. Thus, for the Bell Group, "the most compelling need to acquire new knowledge and skills is economic ... the emerging source of economic strength is brain power ... Unless our schools accept the challenge to create new generations of workers and managers who can understand and use the new technologies, our efforts to renew our economy will fail." This scenario then links the educational system's responsibility to convey the new learning for the information age to the productivity and prosperity of Canada as a nation. "If the education system fails, it will jeopardize its reason for existing and place our national welfare at risk." Systemhouse supports this position in stating that the high technology firms are proponents of increased technological education as they

recognize that "those societies who accept and encourage such technology will be those societies who are more productive and more prosperous."

CURRICULUM AND TEACHING: THE IMPACT OF THE NEW TECHNOLOGIES

Curriculum and teaching methods will change as technology affects both what is learned and how it is learned. A curriculum is defined as what is taught in elementary and secondary schools. The computer would be the main technological tool of, and reason for, inevitable change in the schools. Almost every respondent emphasized the urgency of teaching computer literacy at all levels of the educational system. Computer literacy is generally defined as familiarity with the functions and capacities of the computer. The submission from the Bell Group states: "No one today should be considered well-educated without an understanding of technology and its science base, and without computer literacy." Systemhouse says: "We must create the educational environment where most people become computer literate." But the changes in curriculum do not stop with providing familiarity. IMATA has designated three additional "categories of need - teaching about technology (e.g., informatics courses); teaching through technology (e.g., CAI/CAL); teaching using technology (e.g., using computer as calculator, retrieval device, etc.)." Students must be taught to use the new technologies, to follow their development and, in some cases, to advance the art of computer use. IMATA also sees a need for "learning experiences on how information and communications will be affected and effected by technology."

To facilitate the understanding and use of computers, "new" intellectual skills must be included in the curriculum. Conceptual skills, such as logical thinking, analysis, problem-solving, innovative thinking are essentials because "knowledge and skills may change, but the process of reasoning does not" (Bell). Consequently, the present subject approach will be replaced by more interdisciplinary education. High in priority for this new curriculum will be work-related skills that may cross traditional subject lines to provide a more practical approach to learning.

The reactions of the various firms to the question of changes in the curriculum and in teaching methods present a broadly shared perspective of a drastically altered learning environment. The computer is the tool that will deliver this new teaching, with a steadily increasing use of databanks and computer-assisted learning (CAL). Both of these will

increase the student's control over the content and the structure of learning. The student will have access to vast amounts of information, independently of the teacher. The new thinking skills will enable the learner to choose what is relevant to his or her needs and interests. The computer will also allow the learner to pace his or her learning. The potential application of artificial intelligence means that the computer-based instruction can be adapted to the individual's learning style, strengths, and weaknesses. The vision presented is of a learner, interacting with first-hand, personally relevant, constantly updated information, in a way and at a pace that are suitable to the individual and that prepare him or her for the workplace. The more traditional media, such as textbooks, are assigned to a secondary place since "the student can now gather information that is relevant at a moment's notice" (Electrohome). Digital describes the effect of technology on the curriculum in this way: "More of the student's time could be self-directed in pursuing areas of interest without the requirements of a preset timetable, and yet the student's development will be monitored very closely." This extends the role of the computer to the management of learning, which records the student's use of resources and his or her progress through them.

Amidst these predictions of individualized, responsive education, there is a concern expressed about the mass of information to which the student will be exposed. AES Data proposes that the accelerated rate of dissemination of information that students and teachers will encounter will require a much more efficient use of time. "Otherwise the absorption rate required of students will be so significant that they will all get totally lost in a jungle of databases with a vast amount of information, very little of which they will actively get to utilize." To avoid this pitfall, AES re-emphasizes the necessity of developing skills in logical thinking.

An interesting ramification of this individualization of curriculum is introduced by NABU: "Technology will enable adults to design their own courses by picking segments of courseware from various institutions around the world. This will have implications for current funding for postsecondary institutions." The opportunity to design their own learning experiences is extended to children through the use of the LOGO programming language. LOGO software deliberately avoids

specific subjects. Instead it is intended "to place children in a rich environment offering the possibility of facing the programming activity rather than merely being the consumers of an advanced technology." The Logo, Inc. philosophy respects children's ways of reasoning, their independence of thought, and their use of creativity in solving problems. It is seen as a way of giving the child some control in today's "inflexible" educational system.

It is necessary to consider the changing role of the teacher. Many responses agree with Sask Tel's conception of the new responsibilities for the teacher as "motivation, encouragement, and philosophical guidance." It is no longer essential or desirable for the teacher to provide information - instead he or she becomes an educational "facilitator." "The role of 'mentor' might better describe the ideal result" (Sask Tel).

The teacher must also use the new technology "to monitor and to change course materials virtually on-line in response to student reporting systems that are built into them in a way that has never been possible before with textbook-based course material" (Honeywell). The teachers must be prepared to teach the new technologies and to use them as tools to increase their own effectiveness. The computer is ideal for the teaching of facts, rote learning, immediate feedback, and necessary repetition, and should be used for those purposes. The teacher can use materials and techniques developed elsewhere and can share his or her own expertise more widely by developing computer-assisted learning programs.

The opinions on the future need for the teacher and on his or her role in the introduction of technology into education vary. Honeywell represents the optimistic attitude: "There is ample evidence that the presence of a human teacher will continue to be a very important ingredient in the total learning process." The more critical responses suggest that teachers will have to be cajoled into accepting the new technologies, that they fear the extra work that use of computers may bring (Logo, Inc.), and that, because of fears of possible radical changes to the structure of education, "many educators, almost instinctively, will utilize it in a fairly limited way, showing less interest in exploring its full capabilities for learning than in exposing its limitations" (International Cinemedia). NABU very succinctly states that "the number of teachers will decline."

Training and retraining of teachers is a part of this concept of changed teaching methods. "Our teachers are not learning to present new technology to their students" (AES Data). Sask Tel maintains that: "Incentives for teachers to learn computing must be made very attractive and soon." International Cinemedia recognizes the "traumatic impact of technology on their relatively stable world; positive, supportive effort may do much to make the change more palatable, more successful." Honeywell would like to see teachers' fear of technology turned into a positive view of "the computer, the authoring languages, and the resulting courseware as just another tool, albeit one of a more sophisticated type than the chalk and blackboard." The means for this teacher training, according to the Bell Group, should be "a nationwide program of training and information in the use of computer-assisted learning for primary and secondary school teachers."

Teaching methods will be changed beyond recognition as the individualized, computer-based, student-centred learning described above becomes the norm. Although the computer is the major tool in this transformation, a curriculum designer is certainly not limited to this one medium. Voice synthesis machines, interactive videodiscs, random-access slide projectors, videotex, audio and video teleconferencing, digital telecommunications, satellite and closed circuit television, vast networks of information and communication are available, if not always practical, and it is predicted that the costs will drop. DDS Decision Support Services suggests that "computer conferencing and electronic bulletin boards" as well as networks of microcomputers can be "the new tools of intellectual activity." The impact on teaching methods is generally expected to be nothing short of revolutionary.

The ultimate place for technology in education is still evolving, and industry is leading the way. Much of the in-house training that high tech firms provide consists of computer-based packages that teach effectively at a cost-efficient rate. B.C. Tel has an interactive system that uses color, high-resolution graphics, interactive video, multiple authoring languages, remote delivery, and learner-controlled instruction. The application of this advanced teaching method to a training problem has dramatic results. "The first completed course has resulted in a training time to achieve content mastery of 40 hours compared to 75 hours for

the self-paced course it replaces. In a typical year, this single course will save an estimated $400,000." Other firms have also had positive results, and this widespread success has resulted in general agreement on the positive effect of technology on curriculum and teaching methods. Learning can be hastened and facilitated by using new media to provide high-quality, individualized teaching.

THE CONVERGENCE OF EDUCATION AND TRAINING

The effect of technology and its demands for up-to-date knowledge will undoubtedly affect the relationship between education and training. Although there is a shared conviction that there should and would be changes in the relationships, the definitions of the terms and the implications were not clear. "There will be a continuation of the trend toward training and away from education. However, this comment begs the question regarding what each is and also to what extent we are prepared to pay, especially in the case of education" (IMATA). Using the generally implied definitions of education as what is taught in school, college, and university versus training as what is taught on the job or in specific training courses, the high tech consensus is well expressed by Systemhouse: "One's education should not be concentrated into a few years before entering the job market, but rather spread out over the first fifteen years of employment." Other respondents used terms like lifelong learning, lifelong training, and recurrent education to express the decreasing distinctions between school and work.

No one who leaves formal education at any level to enter the workplace in the new technological era can cease to learn, and the complexity and swiftness of developments often necessitate enrollment in formal educational institutions. This is not limited to people working in high technology itself: the Bell Group predicts that "virtually everyone will be involved in the learning process: students from kindergarten to Ph.D. level, the unemployed, assembly line workers, skilled technical and professional personnel, senior business executives. Lifelong learning and retraining will become the standard for much of our society." Technology has a dual role in this concept of lifelong learning. Much of the education will be about technology and its emerging role in society, and this education will be facilitated by using the new technologies such as computers, videodiscs, and communication networks.

The purpose of continuous learning is closely linked to employment proficiency - as the emphasis moves from the gaining of degrees to the gaining of employment (Systemhouse). Many of the respondents cited cooperative education programs as a successful blend of school and work,

of education and training. IBM believes that cooperative education is beneficial for industry, for schools, and for students. At present, the emphasis in cooperative education is on the educational institution - integrating on-the-job training into teaching programs. Systemhouse suggests a reversal of that practice - cooperative programs where the worker returns to school to meet the educational requirements of his or her job. This idea is based on the European practice of recurrent education.

The changes in both education and training as well as the responsibility for the costs have been outlined by NABU. "In education, courses will be increasingly offered that reflect the world and business environment. Training will be an activity pursued throughout one's life. Initially, training costs will be assumed by industries; however, as jobs become fewer and the demand for the jobs increases, employees will be expected to upgrade or change their abilities on their own time." Honeywell interprets the responsibility for workers more as an opportunity for workers and their employers. "An opportunity now exists for us to create, with the cooperation of industry and the educational system, workers involved both in trades and the professions, who will have at their fingertips and with the approval and motivation of their employers, the opportunity to maintain their self-improvement and hence, competitiveness, both within the environment of their employment and beyond."

Although many respondents were of the opinion that students should be taught subjects that will prepare them for specific jobs and that universities should be more responsible to industry, the Kanata High Technology Training Association (KHTTA) points out the disadvantages of this idea: "Education and training go hand in hand in the sense that training is an integral part of education. There are many individuals in the private sector who promote the idea that the education system exists solely as a training ground for the work force. Such a system loses sight of the humanistic objectives in education and is therefore debasing."

In the high tech firms, the big business potential of employee and in-house education has been recognized. The Bell Group has predicted that "the fastest growing area of learning may well be the education, training, and retraining provided by business for its employees, from production line

workers to senior executives. Estimates of the amount spent by business on education and training in North America range up to $50 billion per year." A new industry has been created, by both high tech firms and other companies, to serve these needs. IMATA, which provides expertise in the application of high technology to training problems, does "not compete with the postsecondary institutions in the area of medium- to long-term courses," but it is finding an enlarging national market for its services. IBM Canada describes its own educational program as equivalent to a "medium-sized university" with 100,000 student days a year. Clearly, education and training, school and work for the high technology industry itself are increasingly overlapping.

Another element is added to the discussion of education and training by International Cinemedia. "The relationship between the individual and all kinds of information will alter significantly; therefore the relationship between education, training, entertainment, and work will also change." As the learner gains control of the information and the way in which he or she learns it, the traditional barriers between education and entertainment will be lowered. Learning has the potential to become a form of recreation and entertainment. At present, education as potential entertainment is limited, in Sask Tel's view, to the home, and the idea "may take some getting used to in the schools and workplace." As employees work fewer hours, NABU predicts that educational activities will increase in importance as a leisure pursuit. For example, adults will upgrade their knowledge and parents will work with their children on activities that may use computers or videodiscs. It is unlikely that adults will use the formal school system for this "education as leisure" pursuit.

The advance of new technology will demand less rigid definitions and timetables for education and training, and will consequently blur the distinctions between school and work. The Bell Group has described the movement as an "increased intermingling" in which everyone will be involved in a more flexible environment that will be more conducive to learning.

EDUCATION FOR TECHNOLOGY

The high technology industry was asked whether or not its needs were being met by the Canadian educational system. The respondents concentrate on the higher education system, and their opinions vary from "the needs of our industry are being reasonably well met" (Systemhouse) to a statement by IBM that "the universities and community colleges are not graduating enough skilled people."

Although the high tech industry has reservations about the education provided by the universities, it does show some understanding of the constraints under which higher education is operating. The Kanata High Technology Training Association (KHTTA) finds the statements "implying a tremendous shortage of skilled labour with respect to the 'High Tech' industry and ... stating that colleges and universities are not doing a thorough enough job ... alarmist and destructive." Rather than assigning blame, KHTTA thinks that the appropriate groups should be getting together to prevent problems from occurring. AES Data concludes that "many of the educational institutions are making a concerted effort to raise the level of technical training being given." Problems exist in funding. "While the need for postsecondary education is increasing, the resources devoted to this are diminishing" (Bell). The consequences are particularly evident in the emerging shortage of engineers and scientists.

Another problem is the result of the technology itself. "The change in technology and in the skills required to use this technology ... is too rapid for traditional training institutes to incorporate in a timely fashion" (Digital). NABU expresses a similar opinion: "Currently, positions requiring technical expertise (engineers, computer scientists, physicists) can be filled. The problem arising is this: the advanced technical area changes so rapidly that it is almost impossible to keep technical expertise all current." International Cinemedia, however, questions how much can be expected of higher education: "Today's advanced technology will inevitably become just everyday industry, probably quite soon. Therefore, I'm not sure that the educational system should cater to what is perceived to be high tech on Monday and old hat by Friday." Industry does understand the constraints of the higher education system and is concerned with the impact of these constraints.

Problems that are specifically mentioned, along with the difficulty of staying up-to-date, are lack of hands-on experience, lack of courseware designers, and what Systemhouse calls the "gap in the hardware/software bridge. Either we get computer science grads with some (usually self-taught) interest in hardware, or electronics grads with a fairly superficial knowledge of software." Mitel believes that more emphasis needs to be placed on technology in order to support the high tech industry in Canada. Extending these themes, the Bell submission paints a grim picture of education's success and promise in filling the needs of industry and, consequently, of Canada's economic future: "The ability of Canada's universities to provide the required quality and quantity of technical resources is not encouraging ... We cannot continue to let our universities decline below world-class standards. From second-class universities we get second-class graduates who will produce second-class technology ... Canada's current state of scientific and engineering education lags behind that of other advanced industrial nations."

The high technology firms are working with the universities to help improve technical education. Spar Aerospace, which draws a parallel between changing a university and turning an ocean liner, is teaching and taking part in faculty exchanges and research projects at various universities. Spar hopes that by communicating and cooperating with the educational system it will be able to make the educational system more aware of technological developments and will thereby encourage and aid in preparing graduates to fill industry's needs. This hopefulness is reserved for the future. The present is more frustrating, for Spar feels "our need is now, and where in Canada do you find the people?" Cooperative education is again commonly mentioned as the means by which universities can evaluate the success of their teaching and by which industry can help to develop suitable courseware. It is clear that the industry believes greater participation by the private sector in education is essential.

The most widely used means by which the industry compensates for deficiencies in the educational institutions has been extensive in-house education and training. As already mentioned, IBM has set up what it describes as a "medium-sized university" to train employees and customers. IBM's Data Processing Customer Education operates because of

a shortage of qualified data processing programmers and managers that could cause many implementations of IBM technology to be cancelled or delayed. This education is also profitable, but "revenue development is not the bottom line for IBM education." AEL Microtel has established a specific division, Teletraining, that offers high technology training as well as more general introductory courses. Digital Equipment Corporation operates 25 training centres internationally to provide instruction to employees and customers. These comprehensive educational programs reinforce the statements that educational institutions are not providing the high tech industry with the qualified employees it needs. In fact, the Bell Group foresees the possibility that "the nonprofit sector will increasingly find itself in competition with the private sector for the provision of education and related services. Less of the total learning will take place in schools and universities."

Sask Tel makes a different demand on education to meet the industry's needs. Owing to the lack of centralized, rationalized purchasing and policy decisions, the educational system is a fragmented market for the services and products of industry. As Sask Tel and other firms note, networking, communication systems, and software markets are difficult to establish because of the variety of hardware currently being purchased. As hardware interface improves, this problem will diminish.

IMATA provides a strong conclusion to this question, as well as an explanation of the source of the problem. "The needs (of industry) are not being met, in large part, because there is no Canadian educational system in place to do this."

AN EDUCATIONAL SYSTEM FOR THE INFORMATION AGE

As indicated in the quotation from IMATA that concluded the last section, the industry's solution to the inadequacies in higher education is action at the national level. "The challenge of the information society demands the development of a national education strategy as a matter of high priority" (Bell). Linking education with the industry's need for personnel, IMATA calls for a review of the "balkanization of education into provincial jurisdictions," with the goal of developing "national education policies and structures." As that is not expected in the near future, "current coordinating mechanisms such as the Council of Ministers of Education should be supported and encouraged to the maximum extent possible." The submission from the Bell Group contains explicit proposals for national action. They include a "greater emphasis on the coordination of provincial and federal education programs and policies" and the "formation of a national forum to stimulate participation in the planning, development, and coordination of manpower training programs by federal and provincial governments, employers, and employee organizations."

Communication on a national level is another possibility. "It will be extremely important for Canadian educational institutions to develop a communication system which will allow them to exchange information within the Canadian geographic parameters.... We should make sure we are leveraging the developments of technology within our own country as they emanate from our educational institutions" (AES Data). NABU suggests an additional use for this communication network. "The provinces must cooperate to form national networks for the transmission of video and computer software. These networks would permit regional and local materials to be inserted. Costs of production of good courseware, no matter what the form, can only be offset by having a larger user base." The ultimate goal of industry's vision for education in the information age is expressed by the Bell Group as a "National Information Age Education Strategy."

A second consistent theme in industry's vision of the future is increasing contact between industry and education; some respondents include government as well. "Government, industry, and education must recognize that they are partners

in a process ... its objective the creation of sound training and education programs which will enable our people to develop professionally and personally so that we will be able to compete for world markets and to continue to grow and create new job opportunities" (KHTTA). When it comes to industry's educational and research needs, Spar Aerospace sees government, industry, and education on a "collision course." Industry needs to have a "critical mass of the leading edge in high technology research" in one location to facilitate joint education and research. Yet governments are dedicated to decentralization, as is evidenced by the scattered placement of the new high technology research facilities. Universities also tend to overlap in, rather than divide, their program development and further scatter the "scarce brain power." In Spar's opinion, centralization would consolidate the sharing of resources and attract new research facilities and personnel.

Honeywell, Digital, Spar Aerospace, and Systemhouse predict that the relationship between education and industry will be consolidated. Honeywell specifically praises such industry-educational relationships as the University of Waterloo Industrial Affiliates Program (in which industry places research facilities on campus) as a sign of the emerging cooperation. In courseware development, Honeywell would prefer that industry create courseware to fill its own needs, while "the generic content of education will continue to be supplied by the educational institutions." This signals a cooperative approach to deciding what should be learned. Digital states that the formation of the Kanata High Technology Training Association "is an indication of how change could evolve. Business cooperation with schools will become increasingly reasonable for the job-related training of its employees." Spar Aerospace adds the warning that universities should not become "trade schools but they have to have a closer link with the new industries." Spar sees that the pressure on educational institutions will be two-sided. Students will be demanding solid training for the high tech industries, and industry, which wants to hire well-trained graduates, will cooperate with the universities to provide the training. Cooperative education will be even more important and more broadly used, according to Systemhouse.

The KHTTA offers a new perspective: "Possible interaction between the private sector and education should not be too

closely defined for fear of restricting it. Cooperative education can be any partnership of activity between the private sector and the educational institutions that results in an enhanced learning condition for the student, so that all parties concerned are winners."

The KHTTA extends this cooperative vision beyond the higher education system. "One major problem in dealing with the question of education and the private sector has been ... the refusal to view the significance and importance of including the primary and secondary school systems in the total picture ... Our first goal must be to re-assess, review and re-organize so that interdependency among all educational levels will exist ... An interplay must exist between the world of work and the world of learning, for neither environment should function independently of the other." The Bell Group picks up on this idea by requesting increased incentives to encourage industry to support secondary education.

Research receives special attention as an area for potential coordinated effort. Spar Aerospace is conducting some research in on-campus sites, as well as encouraging the development of a more rationalized and centralized research structure, involving industry and academia, with greatly increased government support. AES Data proposes that "through the use of various research facilities in most universities, closer ties to pure research in technology will evolve." AES Data sees the use of university-based research facilities as "significantly less expensive to utilize than the high priced R & D labs currently being installed within the industrial domain." An additional benefit would be proposals by industry for the direction of university research "to ensure the practicability of some of the developments that are being pursued within the academic environment" (AES Data).

A third emphasis for education in the information age is the much wider integration of computer-based learning. The Bell submission pays particular attention to the national scope of delivery of education primarily by computer. The recommendations that it includes are: "A nationwide program of training and information in the use of computer-assisted learning for primary and secondary school teachers should be considered by provincial education authorities ... A national facility should be established to conduct research and

evaluate the effectiveness of computer-assisted learning methods and courseware ... A program should be undertaken to develop national computer-assisted learning standards and a universal language for the development of software programs ... Private sector participation should be used, working in collaboration with teachers and educational authorities, to develop the required programs."

The fact that so many respondents emphasize their own successs in providing effective and cost-efficient teaching by computers supports their recommendations for the restructuring of the curriculum to make it available on computers. Honeywell predicts that the introduction of NATAL II (a programming language developed by National Research Council of Canada and then Honeywell) will "facilitate the development of courseware that can be offered to this emerging market." Systemhouse and Digital are also working on the development of courseware authoring languages "to facilitate the ease of computer-based instruction." The high tech industry is investing heavily in research and development of software and hardware for their own use and for all levels of education. The rationale for this is that "computer-assisted instruction may be the only feasible means for both business and the education sectors to cope with the scale of learning resulting from massive job changes and other changes of the information society" (Bell).

Those three themes - national policies, industry-education link, and computer-based learning - describe the future educational systems in terms of industry needs. Some of the replies used a more psychological-sociological analysis of the educational system of the future. International Cinemedia sees that education for the information age will require changes of attitude in the educational system such as "greater willingness to experiment with new forms and content, greater self-confidence that change isn't bad, more intellectual curiosity about significant new ideas, acceptance of the idea of womb-to-tomb learning, and recognition that the school system is one small, if significant, part of that." There is concern for the recipients of much of this education - the children. Within the educational system, there should be a "recognition of responsibility for all children, rather than the tendency to accept those who conform to its predesigned mold and encouragement of students to learn to speculate and solve problems, rather than do subjects" (Logo, Inc.).

Logo, Inc. also presents hypotheses about changes in educators' attitudes. These include "the respect for the different cognitive styles of children and, consequently, an educational approach that is less dogmatic; access to a different conception of apprenticeship based on the development of knowledge by favoring the child's responsibility; a new conception of the child seen as a beginner rather than a human being we must fill with knowledge." Both International Cinemedia and Logo, Inc. can see technology as a tool of this new system, allowing the child-centred education to take place. There is no speculation on how to effect the changes in attitude; rather there is a feeling that teachers fear the coming changes and "rightly so."

As students surpass their teachers in learning the technology itself, Sask Tel sees a situation in which we have "children teaching other children." AES Data predicts the society-wide repercussions of children achieving computer mastery. "They will be surpassing not only their teachers but also their parents. Within the working environment, current senior managers who have not been trained are going to have to be trained so that they, in turn, can utilize the capacities of the students coming out of the educational system." These changes in attitudes towards technology, learning, and learners within the educational and social systems are necessary to build the educational system that high tech is recommending.

The high technology industry is looking for a dramatically changed educational system. The expectations for the direction of change range from the technological to the humanistic - the one certainty being the critical impact of information and communication technology on education.

CRITIQUE

The high technology industry has presented a comprehensive vision of education for technology, of the uses of technology in education, and of the channels through which technological advances could be integrated into the educational system. This vision has strength in its desire to provide employment-related, learner-centred, computer-based learning facilitated through cooperation between industry and the educational system. There is a series of progressive goals in this education:

- Computer literacy for the majority;
- High-quality software for curriculum delivery and support;
- Improved education for scientists, engineers, and computer specialists;
- Increased national productivity and prosperity.

The assumption that seems to underlie many of the submissions is that education for society and the individual in the information age can be provided through increasing use of technology.

Implicit in the above goals is a greater place for technology and the high tech industry in education, the economy, and society. Clearly defined expectations and procedures for modifying the education to fill the needs of industry are outlined.

If education were to be redesigned according to the industry's proposals, it would meet the needs of one sector of industry, but would it also meet the needs of the learner and of society to the same degree? A major element in the industry's vision for education is computer-based learning, which promises to individualize education and give control to the learner. While the high tech industry recognizes the impediments to computer-based learning in the education system, it does not clarify the limitations of the technology itself. Control by the learner assumes an individual with a way of learning that is compatible with computer-assisted learning. The industry's emphasis on logical, analytical

thinking indicates the type of learning and subject matter best suited to CAL. The potential for CAL is tremendous, but the limitations must also be acknowledged.

Although mention is made of the responsibility of the school to integrate all students, that integration could be complicated by the desired reliance on computers for teaching. In practical terms, there are differences in the funds that various school divisions and provinces can spend on computers. In addition, the potential home access to computers favors the more affluent students. Those very real limitations of the computer-based learning are not examined by the industry.

Continuing to look at education of the individual, few of the respondents devote much attention to the development of social skills. In the enthusiasm for creating a better individual learner, the importance of discussion and action with other students should not be diminished. Although some consideration is given to the role of the teacher, he or she would be primarily a tutor for the computer-based learner. Fears about the gap between individualized education and the broader collective world were expressed, but the design for the new education made little mention of strategies to overcome this limitation. The high tech sector is proposing a dramatically new way of educating individuals - focussing on their cognitive abilities. Learners have social needs, emotional needs, and a need for human contact that must be attended to. No one would dispute the capacity of a computer to deliver certain kinds of teaching effectively, but the capacity of the computer to deliver holistic, truly learner-centred learning must be questioned. The perspective of the high tech industry downplayed the attributes of the individual that technology could not enhance, and the result is a vision of the future of education that only includes a part of the process.

The impact of technology on the world of work is potentially monumental, and the importance of education for employment is not about to be questioned. The proposed educational system is heavily weighted towards the education and training of scientists, engineers, and computer specialists. While it is recognized that there is a growing need in those fields, surely they are not the only ones that should be adapted to the information age. This concept has three distinct limitations.

First, communications and information networks are now integral to a number of professions, such as medicine, librarianship, law, social work, counselling, and management. However, aside from a call for general computer literacy, these fields were neglected in the suggestions for higher education. The needs of these disciplines for technical training may not have the highest priority, but they do deserve examination.

Second, the employment future holds more than an increased demand for technically competent employees. Technology will create and expand innumerable other fields of employment with no relation to the use of technology per se. The high tech presentations see technical needs as the predominant educational needs arising from the onslaught of technology. But, for example, the sociological and psychological ramifications of a rapidly changing society will exert pressures in the education sector as well. A comprehensive plan for a responsive educational system should contain a broader vision of the range of needs for employment-related training.

Having said that, the third limitation of the vision is inherent in the premise that education is for industry and for employment. Education should do much more than train people for jobs. The respondents state that they are unwilling to have universities concentrate solely on employment training as they recognize the restricted view this represents of people, of society, and of the value of learning. However, in the overall plan for education, few of them developed that theme. The criticism at this point reflects the same limitation seen in computer-based learning. Education is for the development of the whole person, not just the part of him or her that is employable.

As the vanguard of one of the most traumatic changes in society, high technology firms should be considering the broadest spectrum of technological impact. A positive link has been made between productivity, prosperity, and technological advancement. Thus, high tech has carved out a role for itself in the nation's economic growth. Lesser attention has been paid to its repercussions in other facets of Canadian life - social, political, moral, physical, legal. Technology, integrated into an agency as central as education, has the power to recreate our entire environment. The outcome of this technological innovation should not be

accepted as "good" without careful examination of its very broad benefits and drawbacks. The high technology industry is encouraging and facilitating changes in our educational system and, by extension, our society; yet its analysis of the issues stresses primarily technically related needs, employment, and economic perspectives.

The high technology industry has contributed a very valuable perspective on the direct impact of technology on all levels of education. The accompanying concerns of the implications for individual learners and for the interrelated components of Canada's societal structure have received much less attention. These issues demand careful attention if a full understanding of the effects on education of the new technologies is to be reached.

NOTES

1. Queen's University. Faculty of Arts and Science. Report on New Information Technology, June 1982. Published as a supplement to Queen's Gazette 14, no. 36, 30 November 1982, p. 10.

MAP OF CANADA, showing physical dimensions, provincial and territorial divisions and major cities.

END

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